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Testate amoebae (Arcellinida and Euglyphida) from Pantanal dos Marimbús, Chapada Diamantina, Bahia state, Brazil, including new occurrences

Cínthya Viana Souza Rocha[1], Matheus Santos dos Anjos[1], Deivson Araújo Brandão[1], Caio Ceza da Silva Nunes[2], Mariane Amorim Rocha[1], Patrícia Belini Nishyiama[1], Ricardo Evangelista Fraga[1], Patrícia Maria Mitsuka[3], Márcio Borba da Silva[1*]

1 Laboratório de Zoologia, Instituto Multidisciplinar em Saúde, Universidade Federal da Bahia, Campus Anísio Teixeira, Rua Hormindos Barros 58, Quadra17, Lote 58, Candeias, 45029-094, Vitória da Conquista, BA, Brazil • CVSR: cinthyaviana2@gmail.com https://orcid.org/0000-0001-5975-8543 • MSA: matheussantosdosanjos6@gmail.com https://orcid.org/0000-0001-6120-8698 • DAB: deivson11araujo@gmail.com https://orcid.org/0000-0001-6678-7836 • MAR: marianeamorimrocha.bio@gmail.com https://orcid.org/0000-0002-6185-8663 • PBN: profpatriciabelini@gmail.com https://orcid.org/0000-0002-9495-6171 • REF: ricardoefraga@hotmail.com https://orcid.org/0000-0001-9345-4869 • MBS: biolmarcioborba@gmail.com https://orcid.org/0000-0002-6497-7924

2 Programa de Pós-Graduação em Botânica, Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana, Av. Transnordestina s/n, Novo Horizonte, 44036-900, Feira de Santana, Bahia, Brazil • CCSN: caio-bio2008@hotmail.com https://orcid.org/0000-0002-7912-6049

3 Laboratório de Ecologia Aquática, Departamento de Ciências Humanas, Universidade do Estado da Bahia, Campus VI, Av. Contorno, s/n São José, 46400-000, Caetité, BA, Brazil • PMM: lepmm@hotmail.com https://orcid.org/0000-0003-2222-7743

* Corresponding author

Abstract

Testate amoebae are single-celled protists whose protoplasm is contained within a carapace composed of gelatinous to imbricated chitinous plates having variable chemical compositions. We inventoried the testate amoebae community present in the plankton and periphyton of the Pantanal dos Marimbus swamp in Bahia state, Brazil. Sixty-five samples of plankton and periphyton were analyzed during May and September/2014 and April/2015. We identified 65 taxa of testate amoebae distributed in eight families, 15 genera, 45 species, and 16 varieties. The most representative families were Arcellidae, Centropyxidae, and Difflugiidae, corresponding to 24.6%, 19.7% and 14.8% of the taxa respectively. The periphyton had greater richness (59 taxa) than the plankton (39 taxa). Of the taxa found, 15 represent new records for Bahia and 14 for northeastern Brazil. The Marimbus Pantanal swamp showed an expressive richness of testate amoebae, and our data increases the number of species of these organisms known to Bahia and northeastern Brazil, where work with those organisms is still scarce.

Keywords

Biodiversity, Protozoa, Thecameba

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Introduction

Testate amoebae are single-celled protists whose protoplasm is contained within a carapace (Silva et al. 2020). They are a polyphyletic group, belonging to the Amoebozoa (Tubulinia) and Rhizaria (Cercozoa) (Smith et al. 2008; Adl et al. 2019). The carapaces have a pilomar aperture from which their lobopodia or phyllopod pseudopods are projected for locomotion and/or feeding (Ogden and Hedley 1980; Smith et al. 2008). They are free-living individuals in moist and freshwater habitats, where they can be associated with mosses, peat bogs, aquatic macrophytes, the sediment, and plankton (Lansac-Tôha et al. 2007; Smith et al. 2008).

These organisms are found in several habitats in Brazil, among the plankton, on aquatic macrophytes, and in sediments; their greatest richness of taxa has been recorded in plankton samples, largely due, however, to the larger numbers of studies undertaken in that habitat (Lansac-Tôha et al. 2007). Most of those studies have been concentrated in the southern, southeastern, and midwestern regions Brazil, with less emphasis on the northern and northeastern regions (Lansac-Tôha et al. 2007; Miranda et al. 2015, 2020). According to Silva et al. (2009), the lack of studies of these organisms in the Brazilian northeast is largely due to the paucity of taxonomic specialists for that group.

Studies on testate amoebae have likewise been scarce in Bahia state, with only six publications: Cunha (1916), Neumann-Leitão and Nogueira-Paranhos (1987), Silva et al. (2009), Cruz (2012), Araújo and Nogueira (2016), and Silva et al. (2020). The total described fauna of testate amoebae in Bahia currently consists of 151 taxa.

The Pantanal dos Marimbus is included in the northeastern portion of the Chapada Diamantina National Park, in Bahia state, Brazil (and also within the state-level Marimbus-Iraquara Environmental Protection Area) (Ramos et al. 2012). The Marimbus constitute one of the main aquatic ecosystems of the Chapada Diamantina, with water available in considerable volumes for human use and ecological services, and aids in controlling flooding in the Paraguaçu River (Lessa-filho 2017). Despite the importance of this ecosystem, there have been no previous studies of testate amoebae there.

Due to the scarcity of studies of testate amoebae (Arcellinida and Euglyphida) in both Bahia state and northeastern Brazil, we sought to inventory the species present in the Pantanal dos Marimbus, Chapada Diamantina (municipality of Andaraí), Bahia state, Brazil, and expand our knowledge of the geographic distributions of those amoebae.

Study Area

The Pantanal dos Marimbús swamp is inserted within the Caatinga biome, on the eastern edge of the Chapada Diamantina mountains (12°39′14″S–12°46′49″S to 041°17′00″W–041°21′25″W), in the municipalities of Andaraí and Lençóis, in Bahia state, Brazil. It represents a flood plain formed by the confluence of the Santo Antônio, Utinga, and São José rivers, and can be subdivided into four areas, Remanso, Fazenda Velha, Ferreira, and Baiano (Ramos et al. 2012); the latter was the target area of our study (Fig. 1).

The Marimbus do Baiano area (12°45′S, 41°18′W), located in the municipality of Andaraí, has a dry subhumid climate, with a mean annual temperature of 24.6° C. The rainy season extends from October to April, and the mean annual rainfall is 1045.6 mm (SEI 2014). The Marimbus do Baiano comprises several interconnected lakes, including Lagoa do Baiano, Lagoa da Isca, Lagoa dos Paus, and Olho D'Agua do Peri.

Methods

We collected 65 samples from the Pantanal de Marimbus in May and September/2014 and in April/2015 (10 plankton samples and 12 samples of periphyton each month; except in May/2014 with only 11 periphyton samples).

The plankton samples were randomly collected by trawling using a plankton net (20 µm mesh) for 5 min at each sampling station (Nunes et al. 1996). Periphyton samples were obtained from aquatic macrophytes following the recommendations of Torres and Jebram (1994). All samples were fixed with formaldehyde at a final concentration of 4%, buffered with calcium carbonate (Lansac-Tôha et al. 2014). Reference specimens are deposited in the Limnological Collection of the Universidade Federal da Bahia, Campus Anísio Teixeira (CLCAT).

The samples were subsequently stained with Rose Bengal and only organisms having a stained protoplasm (which indicated that they were alive at the time of sampling) were identified (Velho et al. 1999). The samples were viewed in Sedgwick-Rafter chambers using an optical microscope. Microphotographs were obtained using an Olympus (CX31) optical microscope with a coupled digital camera.

The testate amoebae were identified using following references: Deflandre (1928, 1929), Gauthier Liévre and Thomaz (1958), Decloitre (1962), Vucetich (1973), Ogden and Zivkovic (1983), Ogden (1983, 1984), Velho et al. (1996, 2000), Lansac-Tôha (2000a, 2001), Dabés and Velho (2001), Snegovaya and Alekperov (2005), Mazei and Warren (2012), Reczuga et al. (2015), Kosakyan et al. (2013, 2016), Silva et al. (2016), and Todorov and Bankov (2019).

The species distributions were determined using available references for each state: Acre State (Araújo 2019), Amapá State (Vieira 2017), Amazonas (Arrieira et al. 2016; Arrieira et al. 2017; Reczuga et al. 2015), Bahia (Cunha 1916; Neumann-Leitão and Nogueira-Paranhos 1987; Silva et al. 2009; Cruz 2012; Araújo and Nogueira 2016; Silva 2016; Silva et al. 2020), Ceará (Cunha 1913), Goiás (Lansac-Tôha et al. 2000b; Arrieira et al. 2017), Maranhão (Picapedra et al. 2017), Mato Grosso (Hardoim and Heckman 1996; Missawa 2000; Oliveira and Hardoim 2010; Arrieira et al. 2017), Mato Grosso do

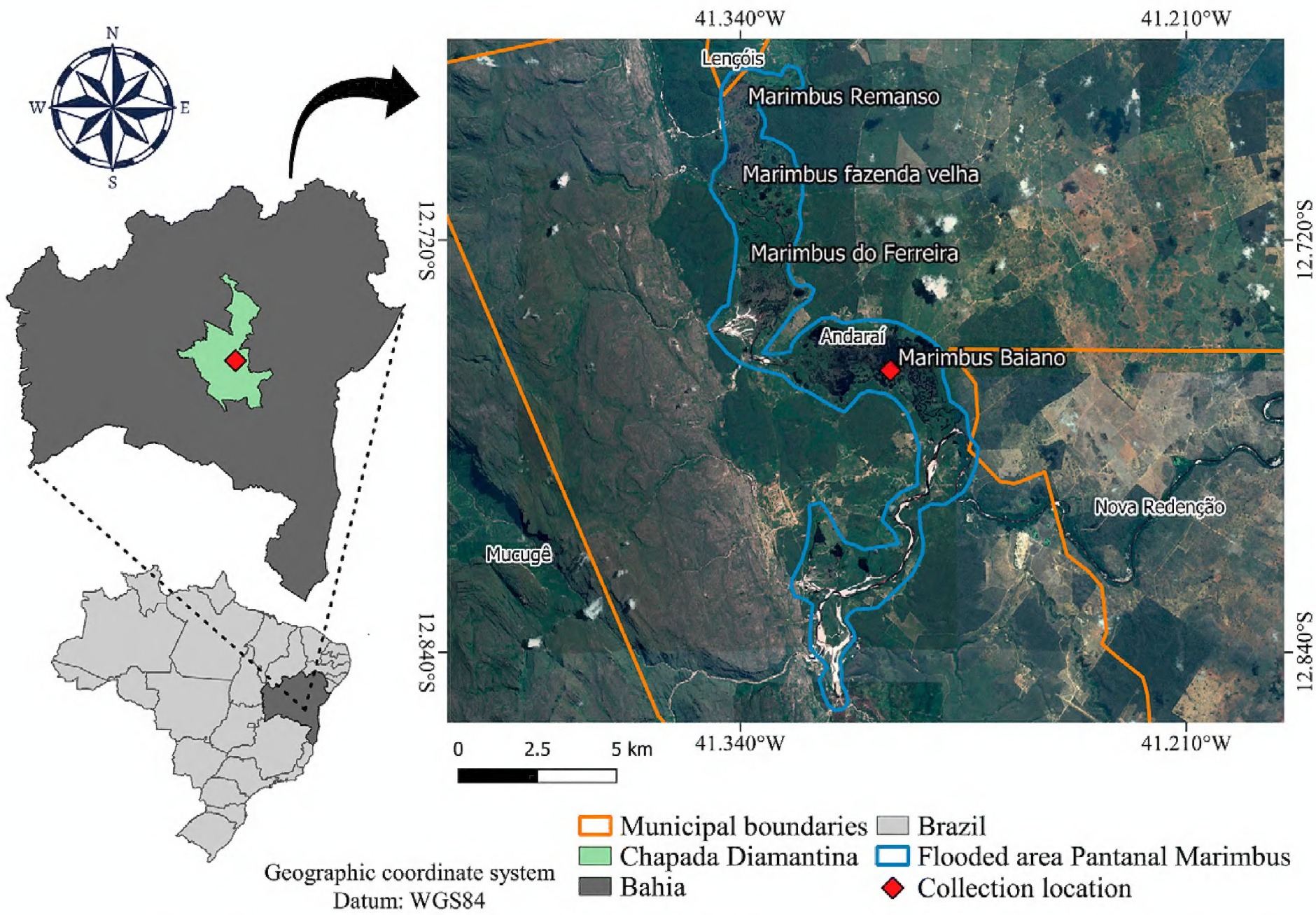

Figure 1. Location of the Pantanal dos Marimbus, in the Chapada Diamantina (municipality of Andaraí), Bahia state, Brazil. The study area at Marimbus do Baiano is marked by a diamond.

Sul (Torres 1996; Velho and Lansac-Tôha 1996; Velho et al. 1996, 1999; Alves et al. 2007, 2008; Schwind et al. 2016), Minas Gerais (Dabés 1995; Dabés and Velho 2001; Souza 2005; López 2009), Pará (Lansac-Tôha et al. 2008; Matsumura-Tundisi et al. 2015; Vieira 2017; Gomes 2020), Paraná (Velho et al. 1996, 1999; Alves et al. 2007, 2008; Lansac-Tôha et al. 2014; Schwind et al. 2016; Arrieira et al. 2017), Pernambuco (Neumann-Leitão and Nogueira-Paranhos 1987), Piauí (Cunha 1916; Picapedra et al. 2017), Rio de Janeiro (Wailes 1913; Cunha 1913, 1916; Miranda and Mazzoni 2015; Souza 2018; Miranda et al. 2020), Rio Grande do Sul (Torres 1996; Rhoden and Pitoni 1999; Leipnitz et al. 2006; Leão et al. 2007, 2009; Picapedra et al. 2019), Santa Catarina (Picapedra et al. 2019), São Paulo (Lahr 2006; Fulone et al. 2005; Misailidis et al. 2017; Mousinho et al. 2018), and the Distrito Federal (Silva et al. 2016; Gomes 2019; Souza et al. 2019). The taxonomic framework is based on the proposal of Adl et al. (2019).

The carapaces of the taxa were analyzed in an expanded diagnosis, and morphometric analyses were carried out considering the following measures: carapace length (L), width (W), diameter (D), Height (H), and aperture (AP). The frequencies of occurrence (%) of the species were determined by the numbers of samples in which they occurred in relation to the total number of samples.

Results

We recorded 61 taxa of testate amoebae distributed among eight families, 15 genera, 45 species, and 16 varieties. The most representative families were Arcellidae (15 taxa), Centropyxidae (12 taxa), and Difflugidae (9 taxa), corresponding to 24.6%, 19.7% and 14.8% of the taxa respectively.

The periphyton had the greatest richness (59 taxa), as compared to plankton (39 taxa), with the genus *Arcella* most common in both the plankton and periphyton samples. Of the 61 taxa identified, 37 occurred in both the periphyton and plankton, with two taxa (*Arcella conica* Playfair, 1917 and *A. peruviana* Reczuga et al. 2015) being exclusive to the plankton, and 22 taxa exclusive to the periphyton (Table 1). Our results added 15 new taxa of testate amoebae to those known for Bahia state, and 14 new taxa for the northeastern region of Brazil. Of the new taxa recorded in Bahia, seven are representatives of the family Hyalosphenidae.

Newly recorded taxa in Bahia state and northeastern Brazil

Family Arcellidae Ehrenberg, 1830

***Arcella costata* var. *angulosa* Perty, 1852**
Figure 2D, E

New record. BRAZIL – Bahia • Andaraí, Pantanal dos

Table 1. Frequency of occurrence (%) of testate amoebae species found in plankton and in the periphyton of the Pantanal dos Marimbus, in the Chapada Diamantina (municipality of Andaraí), Bahia state, Brazil. PL = Plankton, PF = Periphyton, * = new record for Bahia state, ** = new record for northeastern Brazil.

Taxon	May 2014		Sept. 2014		Apr. 2015		Total	
	PL	PF	PL	PF	PL	PF	PL	PF
Family Arcellidae Ehrenberg, 1830								
Arcella brasiliensis Cunha, 1913	50.0	9.1	0.0	16.7	0.0	8.3	16.7	11.4
Arcella conica Playfair, 1917	10.0	0.0	0.0	0.0	0.0	0.0	3.3	0
Arcella costata Ehrenberg, 1847	50.0	18.2	0.0	50.0	20.0	16.7	23.3	28.6
****Arcella costata* var. *angulosa* Perty, 1852	10.0	18.2	0.0	0.0	0.0	0.0	3.3	5.7
Arcella discoides Ehrenberg, 1843	70.0	81.8	30.0	10.0	50.0	100	50.0	94.3
Arcella discoides var. *pseudovulgaris* Deflandre, 1928	0.0	9.1	0.0	33.3	0.0	8.3	0.0	17.1
Arcella hemisphaerica Perty, 1852	70.0	72.7	0.0	66.7	20.0	25.0	30.0	54.3
Arcella hemisphaerica f. *undulata* Deflandre, 1928	30.0	27.3	10.0	33.3	0.0	0.0	13.3	20
Arcella intermedia f. *undulata* Deflandre, 1928	20.0	45.5	0.0	0.0	0.0	0.0	6.7	14.3
Arcella megastoma Pénard, 1902	0.0	0.0	0.0	33.3	0.0	8.3	0.0	14.3
****Arcella peruviana* Reczuga et al., 2015	0.0	0.0	10.0	0.0	0.0	0.0	3,3	0
****Arcella rota* Daday, 1905	0.0	0.0	0.0	0.0	0.0	8.3	0.0	2.9
Arcella vulgaris Ehrenberg, 1830	0.0	0.0	0.0	8.3	10.0	0.0	3.3	2.9
Arcella vulgaris var. *undulata* Deflandre, 1928	30.0	27.3	10.0	0.0	10.0	25.0	16.7	17.1
Arcella vulgaris var. *wailesi* Deflandre, 1928	0.0	0.0	0.0	16.7	0.0	0.0	0.0	5.7
Family Centropyxidae Ehrenberg, 1830								
Centropyxis aculeata Ehrenberg, 1838	30.0	81.8	20.0	91.7	20.0	91.7	23.3	88.6
Centropyxis aculeata var. *minima* Van Oye, 1956	10.0	27.3	0.0	0.0	0.0	0.0	3.3	8.6
Centropyxis aculeata var. *oblonga* Deflandre, 1929	0.0	36.4	0.0	33.3	0.0	18.2	0.0	28.6
****Centropyxis aculeata* var. *tropica* Deflandre, 1929	0.0	36.4	0.0	16.7	0.0	25.0	0.0	25.7
Centropyxis cassis Wallich, 1864	0.0	18.2	0.0	16.7	10.0	0.0	3.3	11.4
Centropyxis cassis var. *spinifera* Playfair, 1918	0.0	9.1	0.0	16.7	0.0	8.3	0.0	11.4
Centropyxis constricta Ehrenberg, 1841	10.0	27.3	0.0	33.3	10.0	8.3	6.7	22.9
Centropyxis discoides Penard, 1902	0.0	0.0	0.0	0.0	0.0	16.7	0.0	5.7
Centropyxis ecornis Ehrenberg, 1841	10.0	72.7	0.0	50.0	0.0	8.3	3.3	42.9
Centropyxis gibba Deflandre, 1929	10.0	63.6	0.0	75.0	0.0	75.0	3.3	71.4
Centropyxis hirsuta Deflandre, 1929	0.0	36.4	0.0	58.3	10.0	33.3	3.3	42.9
Centropyxis platystoma Pénard, 1902	20.0	45.5	0.0	16.7	20.0	16.7	13.3	25.7
Family Difflugiidae Awerintzew, 1906								
Difflugia acuminata Ehrenberg, 1838	0.0	27.3	0.0	16.7	20.0	0.0	6.7	14.3
Difflugia elegans Pénard, 1899	30.0	10.0	20.0	50.0	10.0	41.7	16.7	62.9
Difflugia lobostoma Leidy, 1879	0.0	45.5	0.0	41.7	10.0	41.7	3.3	42.9
Difflugia lobostoma var. *cornuta* Gauthier-Lievrè & Thomas, 1958	0.0	9.1	0.0	8.3	0.0	0.0	0.0	5.7
****Difflugia lobostoma* var. *globulus* Playfair, 1917	0.0	18.2	0.0	16.7	0.0	0.0	0.0	11.4
****Difflugia microclaviformis* Kourov, 1925	10.0	0.0	0.0	8.3	0.0	0.0	3.3	2.9
Difflugia oblonga Ehrenberg, 1838	0.0	27.3	0.0	25	20.0	16.7	6.7	22.9
Difflugia pleustonica Dioni, 1970	10.0	9.1	0.0	8.3	0.0	0.0	3.3	5.7
Difflugia schuurmani Van Oye, 1932	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.9
Family Euglyphidae Wailes, 1919								
Euglypha acanthophora Ehrenberg, 1840	20.0	81.8	10.0	16.7	30.0	41.7	20.0	45.7
Euglypha acanthophora var. *brevispina* Penard, 1902	20.0	18.2	0.0	33.3	0.0	33.3	6.7	28.6
Euglypha filifera Pénard, 1880	20.0	10.0	10.0	66.7	10.0	50.0	13.3	71.4
Euglypha rotunda Wailes, 1911	10.0	45.5	0.0	50.0	10.0	66.7	6.7	54.3
****Euglypha strigosa* var. *glabra* Wailes & Penard, 1911	0.0	18.2	0.0	0.0	0.0	0.0	0.0	5.7
Euglypha tuberculata Dujardin, 1841	10.0	27.3	0.0	25	10.0	16.7	6.7	22.9
Family Hyalosphenidae Schultze, 1877								
****Gibbocarina galeata* (Penard, 1890)	0.0	18.2	0.0	0.0	0.0	0.0	0.0	5.7
****Longinebela penardiana* (Deflandre, 1936)	0.0	27.3	0.0	8.3	0.0	0.0	0.0	11.4
*Longinebela tubulosa (*Penard, 1890)	10.0	0.0	0.0	8.3	0.0	0.0	3.3	2.9
****Nebela barbata* Leidy, 1874	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.9
****Nebela collaris* (Ehrenberg, 1848)	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.9
****Padaungiella tubulata* (Brown, 1910)	0.0	18.2	0.0	0.0	0.0	0.0	0.0	5.7
****Planocarina carinata* (Archer 1867)	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.9
***Quadrulella symetrica* (Wallich, 1863)	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.9
Family Lesquereusiidae Jung, 1942								
Lesquereusia globulosa Thomas et Gauthier-Lièvre, 1959	0.0	0.0	0.0	16.7	0.0	33.3	0.0	17.2
Lesquereusia modesta Rhumbler, 1896	10.0	9.1	0.0	0.0	10.0	0.0	6.7	2.9

Taxon	May 2014		Sept. 2014		Apr. 2015		Total	
	PL	PF	PL	PF	PL	PF	PL	PF
Lesquereusia minor Walton, 1930	10.0	63.6	10.0	25.0	10.0	25	10.0	37.1
Lesquereusia spiralis Ehrenberg, 1840	0.0	63.6	0.0	33.3	0.0	16.7	3.3	37.1
Lesquereusia spiralis var. *hirsuta* Thomas & Gauthier-Lievrè, 1960	0.0	18.2	0.0	8.3	10.0	8.3	3.3	11.4
Family Netzeliidae Kosakyan et al., 2016								
Ciclopyxis kahli var. *cyclostoma* Bonnet & Thomas, 1960	0.0	9.1	0.0	41.7	0.0	0	0.0	17.1
Netzelia corona (Wallich, 1864)	20.0	18.2	0.0	0.0	10.0	25	10.0	14.3
Netzelia gramen (Penard, 1902)	0.0	72.7	0.0	75.0	10.0	33.3	3.3	60.0
Netzelia oviformis (Cash, 1909)	10.0	90.9	0.0	75.0	30.0	66.7	13.3	77.1
Family Trinematidae Hoogenraad & Groot, 1940								
*Trinema enchelys (*Ehrenberg, 1838)	10.0	54.6	0.0	50.0	10.0	66.7	6.7	57.1
Insertae sedis								
***Argynnia caudata* (Leidy, 1879)	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.9

Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT395, CLCAT408.

Identification. Carapace transparent, colorless, or yellowish, with 5–7 facets in apical view. Trapezoidal in side view, with the diameter of the carapace greater than its height. The pseudostome is circular, central, and clearly invaginated. L = 80–115 µm (93 ± 14.83), H = 40–60 µm (56 ± 8.94), PO = 20–37 µm (29.4 ± 6.07) (*n* = 5).

Taxonomic remarks. This variety differs from *Arcella costata* by having an angular, trapezoidal shape, not circular as in *A. costata* (sensu stricto). Our specimens were larger than those described by Deflandre (1928; D = 60–63 µm, H = 32–39 µm, AP = 11 µm).

Distribution in Brazil. Distrito Federal, Mato Grosso, Minas Gerais, São Paulo.

***Arcella peruviana* Reczuga et al., 2015**

Figure 2H, I

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.416′S, 041°18.516′W; IX.2014; CLCAT554.

Identification. Carapace yellowish and transparent, with clearly evident angles in apical view. The height of the carapace is slightly greater than the maximum diameter. The apical region has a larger diameter in lateral view than the oral region. The aperture is centrally located,

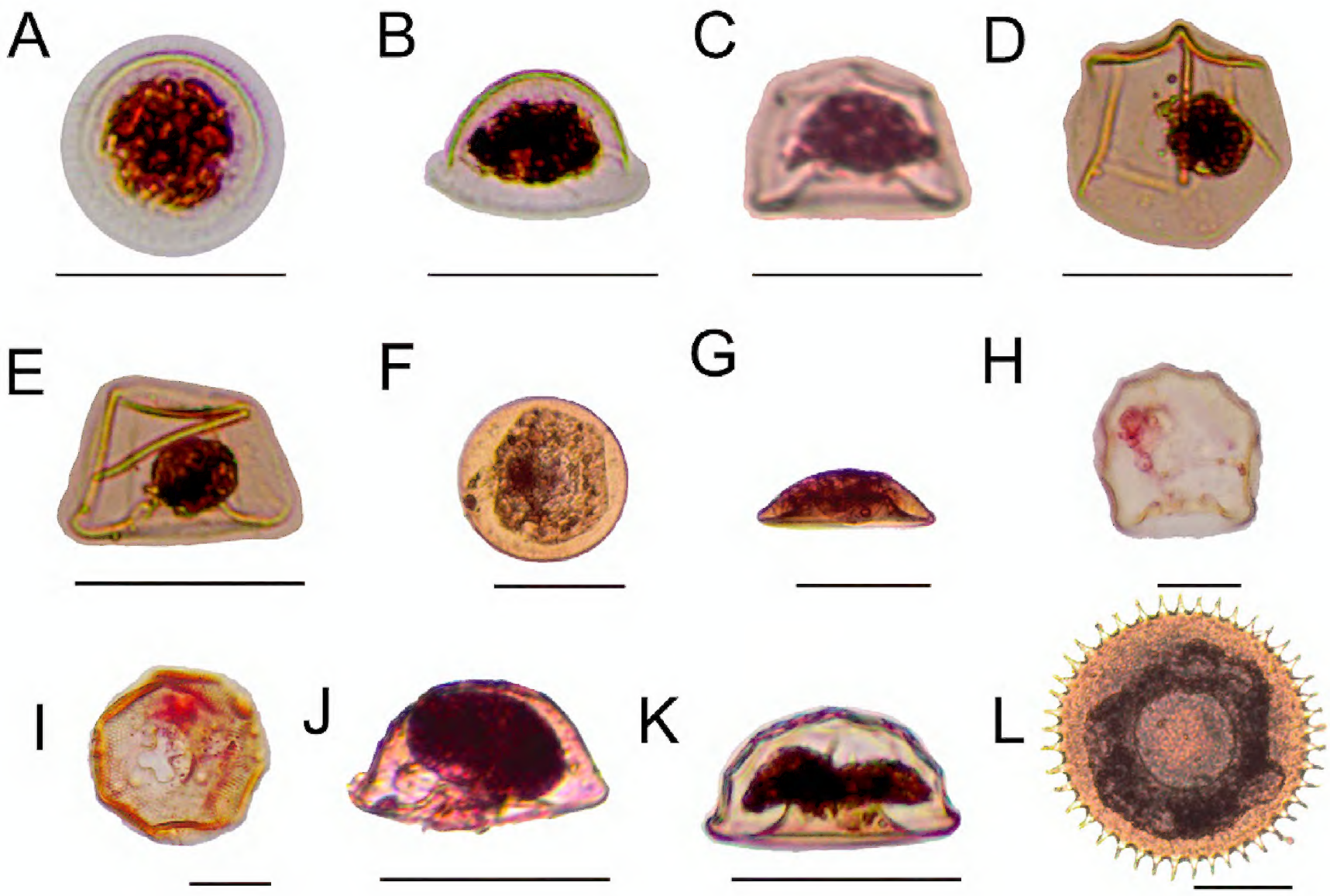

Figure 2. Testate amoebae of the Pantanal dos Marimbus, in the Chapada Diamantina (municipality of Andaraí), Bahia state, Brazil. **A, B.** *Arcella brasiliensis*. **C.** *Arcella costata*. **D, E.** *Arcella costata* var. *angulosa*. **F, G.** *Arcella discoides*. **H, I.** *Arcella peruviana*. **J.** *Arcella vulgaris*. **K.** *Arcella vulgaris* var. *undulata*. **L.** *Arcella rota*. Scale bars: A–G, J–L = 100 µm; H, I = 50 µm.

slightly invaginated, and cross-shaped, with four obvious lobes. D = 48–63 µm (54.3 ± 5.7), H = 50–65 µm (57.9 ± 5.57), AP = 15–20 µm (18.7 ± 2.06) (*n* = 10).

Taxonomic remarks. This species can be confused with *Arcella mitrata* var. *spectabilis* Deflandre, 1928, but differs by being smaller, with a distinct, cross-shaped aperture.

Distribution in Brazil. Amazonas, Rio de Janeiro.

***Arcella rota* Daday, 1905**
Figure 2L

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.916′S, 041°18.777′W; IV.2015; CLCAT750.

Identification. Carapace yellowish, similar in shape to the side view of a watch glass, round in oral view, with short, thorn-like projections covering the entire side of the carapace, similar to a gear. The aperture is round, centrally located, and invaginated. D = 230–240 µm (236.67 ± 5.77), H = 50–55 µm (55 ± 5), AP = 100–105 µm (101.67 ± 2.89) (*n* = 3).

Distribution in Brazil. Acre, Amapá, Distrito Federal, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná.

Família Centropyxidae Ehrenberg, 1830

***Centropyxis aculeata* var. *tropica* Deflandre, 1929**
Figure 3B

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT420, CLCAT432 • same locality; 12°45.416′S, 041° 18.516′W; IX.2014; CLCAT469, CLCAT476 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT756, CLCAT765, CLCAT766.

Identification. Carapace subcircular, composed of exogenous materials, like agglutinated particles; is spherical in dorsal view, flattening towards the aperture. The aperture (which is located in the anterior region), generally has a more circular and regular contour than the typical variety. There are variable numbers of spines in the posterior region, which are longer than those of the typical variety. L = 90–140 µm (106.11 ± 15.37), AP = 35–50 µm (44.44 ± 6.82) (*n* = 9).

Distribution in Brazil. Amazonas, Mato Grosso do Sul, Minas Gerais, Paraná, São Paulo.

Family Difflugidae Awerintzew, 1906

***Difflugia lobostoma* var. *globulus* Playfair, 1917**
Figure 3E, F

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W;

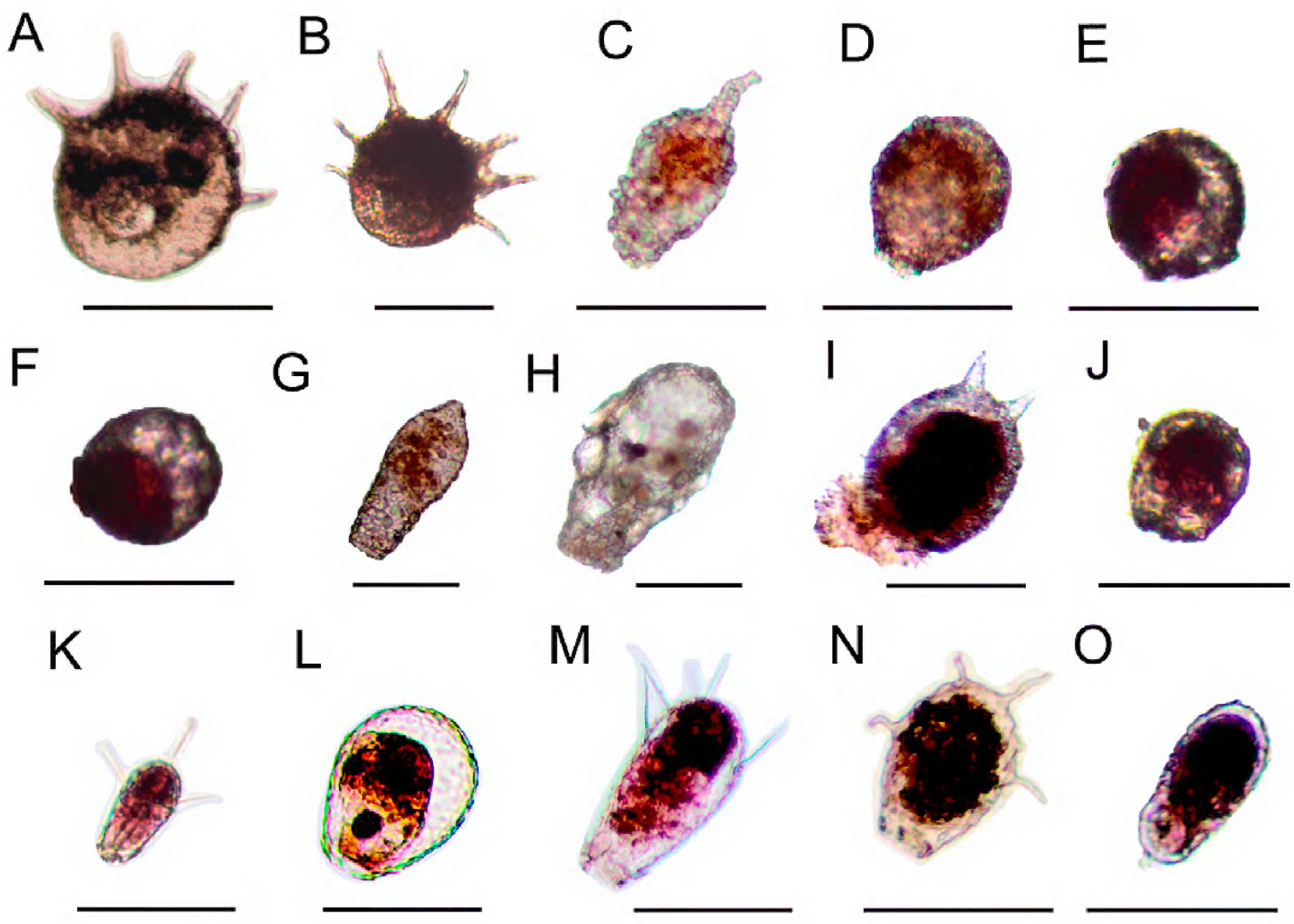

Figure 3. Testate amoebae of the Pantanal dos Marimbus, in the Chapada Diamantina (municipality of Andaraí), Bahia state, Brazil. **A.** *Centropyxis aculeata*. **B.** *Centropyxis aculeata* var. *tropica*. **C.** *Difflugia elegans*. **D.** *Difflugia lobostoma*. **E, F.** *Difflugia lobostoma* var. *globulus*. **G.** *Difflugia microclaviformis*. **H.** *Difflugia oblonga*. **I.** *Netzelia corona*. **J.** *Netzelia gramen*. **K.** *Euglypha filifera*. **L.** *Euglypha strigosa* var. *glabra*. **M**. *Euglypha acanthophora*. **N.** *Argynnia caudata*. **O.** *Trinema enchelys*. Scale bars: 100 µm.

V.2014; CLCAT408, CLCAT420, CLCAT421 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT476, CLCAT515.

Identification. Carapace spherical, circular, uncompressed, and composed of agglutinated exogenous particles. The aperture is lobulated, with 3 or 4 very evident lobes.

Taxonomic remarks. This variety differs from the typical variety by being smaller and having a well-defined circular shape. C = 60–65 µm (62.5 ± 2.89), L = 50–65 µm (55.75 ± 6.5), AP = 15–20 µm (18.75 ± 2.5) (*n* = 4).

Distribution in Brazil. Mato Grosso do Sul, Rio Grande do Sul, São Paulo.

***Difflugia microclaviformis* Kourov, 1925**
Figure 3G

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT382 • Same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT480.

Identification. Carapace pyriform-elongate, wider in the posterior region and narrowing towards the aperture region; composed of agglutinated particles, with a straight protuberance (similar to a horn) on the posterior portion of the carapace; the aperture is circular. L = 150–165 (158.33 ± 7.64), W = 60–65 µm (61.67 ± 2.89), AP = 20–30 µm (25 ± 5) (*n* = 3).

Taxonomic remarks. Mazei and Warren (2012) considered *D. pyriformis* var. *venusta* Penard, 1902, *D. oblonga* var. *venusta* Cash & Hopkinson, 1909, and *D. oblonga* var. *microclaviformis* Kourov, 1925 all to be synonyms of *D. microclaviformis*.

Distribution in Brazil. Distrito Federal, Mato Grosso, Minas Gerais, Pará, Paraná, Rio de Janeiro.

Family Euglyphidae Wailes, 1919

***Euglypha strigosa* var. *glabra* Wailes & Penard, 1911**
Figure 3L

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT423, CLCAT424.

Identification. Carapace ovoid and compressed laterally, composed of small, overlapping, oval plates. The aperture is circular and surrounded by denticulate plates. This variety differs from the typical variety by not having thorn-like projections along the carapace. L = 100–110 µm (103.33 ± 5.77 µm), W = 65–80 µm (73.33 ± 7.64 µm), AP = 30 µm (30 ± 0) (*n* = 3).

Distribution in Brazil: Rio de Janeiro.

Family Hyalosphenidae Schultze, 1877

***Gibbocarina galeata* (Penard, 1890)**
Figure 4A

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT420, CLCAT422.

Identification. Carapace colorless, transparent, pyriform-elongate, composed of small, oval, circular, or irregular plates, is laterally compressed, with distinctly compressed lateral margins and a thick lateral keel. The aperture is linear or slightly curved, with a collar. Two small lateral pores are present, one on each side of the carapace. L = 125–170 µm (147.5 ± 31.82 µm), W = 65–90 µm (77.5 ± 17.68 µm), AP = 25–30 µm (27.5 ± 3.54 µm) (*n* = 2).

Taxonomic remarks. This taxon can be confused with species of the genus *Planocarina*, but *Gibbocarina galeata* has hollow keel and *Planocarina* a flat keel. Kosakyan et al. (2016) considered *Gibbocarina gracilis* (Penard, 1910) to be a synonym of *G. galeata,* although the former is smaller than the latter. We found both species in our study, but we follow the classification of Kosakyan et al. (2016) so that there is a discrepancy between the measurements of our specimens and those of *G. galeata*.

Distribution in Brazil. Rio de Janeiro, Minas Gerais.

***Longinebela penardiana* (Deflandre, 1936)**
Figure 4B

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT420, CLCAT424, 431 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT480.

Identification. Carapace colorless, transparent, elongate-pyriform, with the sides gradually tapering from the aboral region towards the aperture, compressed laterally, and with lateral protuberances close to the neck. The carapace is composed of small oval plates, circular, overlapping, and randomly arranged. The aperture is oval and bounded by a collar. L = 110–170 µm (124 ± 26.08 µm), W = 45–60 µm (52 ± 5.7 µm), AP = 20–27.5 µm (22.7 ± 3.15 µm) (*n* = 5).

Taxonomic remarks. Although the original description reported the presence of two visible lateral pores along the first third of the lateral margins, they were not observed in our specimens. *Longinebela penardiana* can be confused with *Longinebela tubulosa* (Penard, 1890); it differs, however, by being smaller.

Distribution in Brazil. Amazonas, Distrito Federal, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraná, Rio Grande do Sul.

***Nebela barbata* Leidy, 1874**
Figure 4E

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT424.

Identification. Carapace transparent, compressed laterally, and composed of oval, circular, and elongated plates; it is entirely covered by spine-like projections, with the aboral region circular, and the oral region with a long, distinct neck. The aperture is oval, with a thin collar. L =

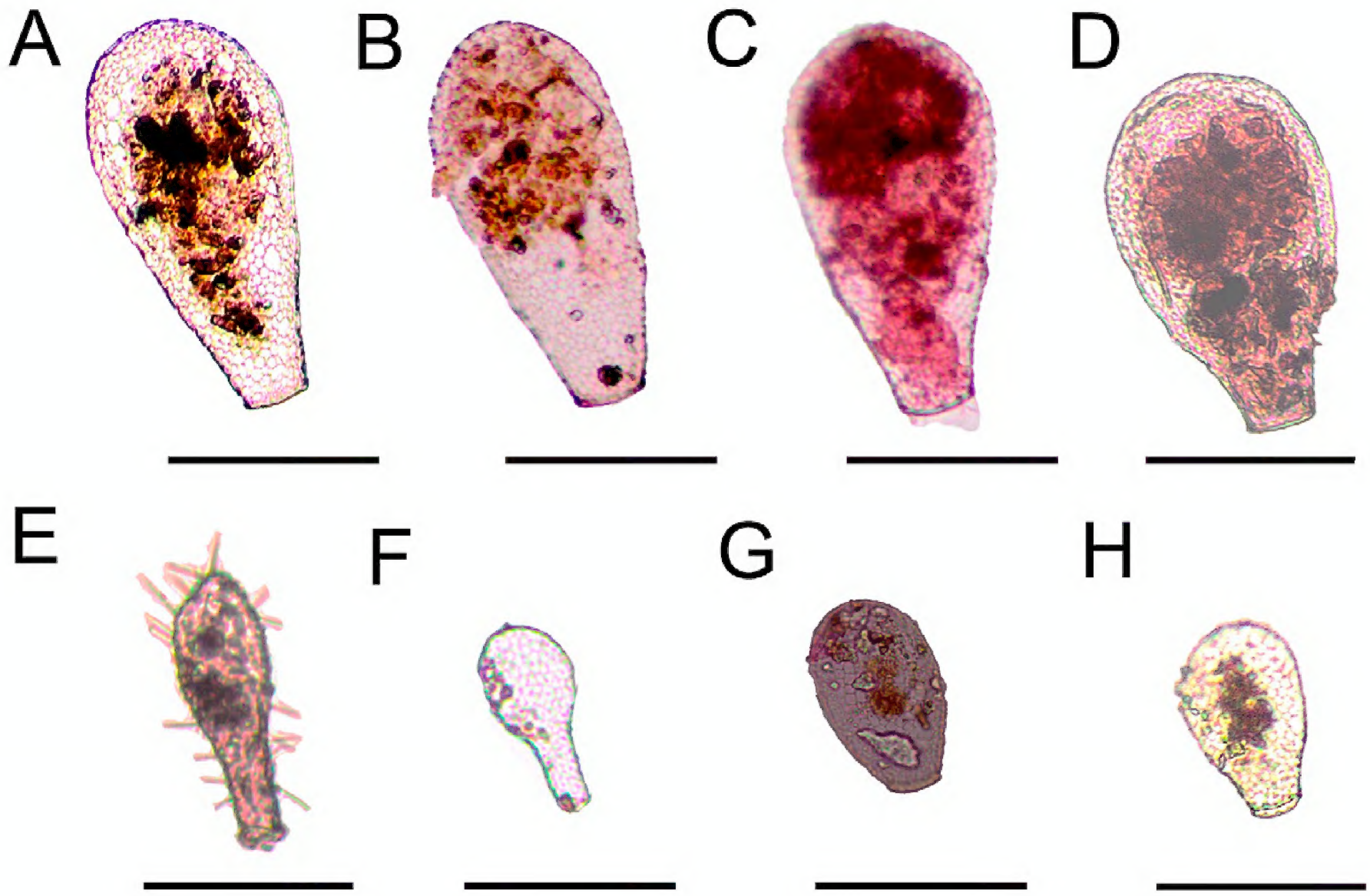

Figure 4. Testate amoebae of the Pantanal dos Marimbus, in the Chapada Diamantina (municipality of Andaraí), Bahia state, Brazil. A. *Gibbocarina galeta*. B. *Longinebela penardiana*. C. *Longinebela tubulosa*. D. *Planocarina carinata*. E. *Nebela barbata*. F. *Padaungiella tubulata*. G. *Quadrulella symmetrica*. H. *Nebela colaris*. Scale bars: 100 µm.

120 µm, W = 50 µm, AP = 30 µm (*n* = 1).

Distribution in Brazil. Distrito Federal, Mato Grosso, Minas Gerais, Rio de Janeiro.

***Nebela collaris* (Ehrenberg, 1848)**
Figure 4H

New record BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT420.

Identification. Carapace laterally compressed and composed of oval and rounded plates, transparent, pyriform, gradually tapering from the aboral region to the oral region, with a short neck. The aperture has an evident collar. L = 85 µm, W = 53 µm, AP = 22 µm (*n* = 1).

Taxonomic remarks. *Nebela collaris* differs from other species by its shape and size.

Distribution in Brazil. Mato Grosso, Minas Gerais, Pará, Rio Grande do Sul.

***Padaungiella tubulata* (Brown, 1910)**
Figure 4F

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT420, CLCAT424.

Identification. Carapace clearly elongated and laterally compressed, transparent, with a rounded aboral region and a tapered oral region that forms a slender neck; it is composed of oval, circular, or rarely square plates that do not overlap. Aperture oval, with an evident collar. L = 70–80 µm (76.67 ± 5.77), W = 30–40 µm (36.67 ± 5.77), AP = 15 µm (15 ± 0) (*n* = 3).

Taxonomic remarks. This species can be confused with *Padaungiella lageniformis* (Penard, 1980), although it is smaller.

Distribution in Brazil. Distrito Federal, Minas Gerais, Pará.

***Planocarina carinata* (Archer 1867)**
Figure 4D

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT420.

Identification. Carapace transparent and colorless, compressed in lateral view, oval-pyriform, composed of oval, circular, and elongated plates, with an evident flat keel from the end of the well-defined neck. The aperture is oval with a thin collar. L = 150 µm, W = 92 µm, AP = 30 µm (*n* = 1).

Taxonomic remarks. This species can be confused with *Planocarina marginata* (Penard, 1902), although the keel of *P. marginata* is more narrow.

Distribution in Brazil. Mato Grosso, Pará.

***Quadrulella symmetrica* (Wallich, 1863)**
Figure 4G

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT424.

Identification. Carapace ovoid or pyriform, gradually tapering from the aboral to the oral region, compressed laterally, transparent, composed of clear square plates of different sizes; those next to the aperture are smaller. Aperture terminal and features a thin collar. L = 90 µm, W = 50 µm, AP = 27 µm (*n* = 1).

Distribution in Brazil. Maranhão, Mato Grosso, Minas Gerais, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina.

Insertae sedis

***Argynnia caudata* (Leidy, 1879)**
Figure 3N

New record. Brazil- Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775'S, 041°18.545'W; V.2014; CLCAT431.

Identification. Carapace transparent, ovoid, laterally compressed, composed of articulated (rarely overlapping) polygonal or circular plates. Carapace with 4 protuberances (spines); the aperture does not have a collar. L=80 µm, W= 60 µm, AP =20 µm (*n*=1).

Distribution in Brazil. Rio de Janeiro, Rio Grande do Sul.

Other taxa recorded in this study

Family Arcellidae Ehrenberg, 1830

***Arcella brasiliensis* Cunha, 1913**
Figure 2A, B

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT386, CLCAT390, CLCAT395, CLCAT396, CLCAT423 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT464 • same locality; 12°45.916′S, 041° 18.777′W; IV.2015; CLCAT 749.

Identification. Carapace transparent, colorless or yellowish, circular in ventral view, with a central, circular, invaginated aperture; hemispherical in lateral view, with an evident marginal ring and visible invagination of the aperture. D = 65–80 µm (74.5 ± 5.50), W = 40–55 (44 ± 5.68), AP = 17.5–30.0 (20.75 ± 3.34) (*n* = 10).

Distribution in Brazil. Amapá, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul.

***Arcella costata* Ehrenberg, 1847**
Figure 2C

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT380, CLCAT386, CLCAT408 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT468, CLCAT521 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT590, CLCAT753.

Identification. Carapace transparent, colorless or yellowish, polygonal, with seven angulations on the oral face, and with a circular, central, and clearly invaginated aperture; the carapace diameter is greater than its height. D = 60–110 µm (90.56 ± 15.5), H = 40–60 (50 ± 5), AP = 25–40 µm (28.33 ± 5) (*n* = 9).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul e Santa Catarina.

***Arcella discoides* Ehrenberg, 1843**
Figure 2F, G

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT386, CLCAT430, CLCAT431 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT470, CLCAT521 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT749, CLCAT763.

Identification. Carapace transparent, yellowish, disc-shaped, circular in oral view, semicircular in side view, with the aperture central, circular, and invaginated. Carapace height is approximately 1/3 of its diameter. D = 60–110 µm (81.5 ± 16.68), H = 20–40 µm (26.5 ± 6.26) AP = 20–30 µm (24 ± 3.94) (*n* = 10).

Distribution in Brazil. Amazonas, Bahia, Ceará, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, São Paulo.

***Arcella vulgaris* Ehrenberg, 1830**
Figure 2J

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.416′S, 041°18.516′W; IX.2014; CLCAT470 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT588.

Identification. Carapace transparent, without undulations; circular in oral view, with a central and round aperture; hemispherical in side view, with a distinct border and an evident invagination of the aperture. L = 90–100 µm (97.5 ± 5), W = 50–55 µm (51.25 ± 2.5), AP = 30–35 µm (31.25 ± 2.5) (*n* = 4).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo.

***Arcella vulgaris* var. *undulata* Deflandre, 1928**
Figure 2K

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V. 2014; CLCAT381, CLCAT399, CLCAT431 • same

locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT552 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT592, CLCAT748, CLCAT766.

Identification. Carapace transparent, circular in oral view, with a central, round aperture; hemispherical in lateral view, with evident invagination of the aperture. This variety differs from the typical variety as the carapace surface has undulations. L = 90–110 µm (97 ± 6.30), W = 40–60 µm (46.11 ± 6.97), AP = 20–40 µm (26.67 ± 6.61) (*n* = 9).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Mato Grosso, Mato Grosso do Sul, Pará, Paraná, Rio de Janeiro, São Paulo.

Family Centropyxidae Ehrenberg, 1830

***Centropyxis aculeata* Ehrenberg, 1830**
Figure 3A

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V. 2014; CLCAT382, CLCAT404, CLCAT432 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT468, CLCAT548 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT590, CLCAT765.

Identification. Carapace circular or oval, composed of exogenous agglutinated particles; spherical in dorsal view, but flattening towards the aperture; flat in ventral view, with a round or oval aperture in the anterior region of the carapace. Five or more lateral spines are visible in the posterior region. D = 85–140 µm (104.5 ± 17.23), AP = 25–50 µm (39.5 ± 9.85) (*n* = 10).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo.

Family Difflugidae Awerintzew, 1906

***Difflugia elegans* Pénard, 1899**
Figure 3C

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT382, CLCAT396, CLCAT408, CLCAT430 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT469, CLCAT554 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT761.

Identification. Carapace pyriform, tapering towards the aperture, composed of exogenous materials, with an oblique spine in the aboral region. The aperture is circular and terminal. L = 80–130 µm (107.5 ± 20.98), W = 40–60 µm (51 ± 6.99), AP = 20–40 µm (31.5 ± 6.26) (*n* = 10).

Distribution in Brazil. Amapá, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina.

***Difflugia lobostoma* Leidy, 1879**
Figure 3D

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT400, CLCAT421, CLCAT430 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT468, CLCAT515 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT756, CLCAT766.

Identification. Carapace oval, uncompressed, and composed of agglutinated exogenous particles. The aperture is trilobed, and delimited by an obvious collar. L= 75–100 µm (86.2 ± 7.67), W = 50–80 µm (64.5 ± 9.26), AP = 15–35 µm (23.5 ± 7.46) (*n* = 10).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, São Paulo.

***Difflugia oblonga* Ehrenberg, 1838**
Figure 3H

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT404, CLCAT430 • same locality; 12°45.416′S, 041° 18.516′W; IX.2014; CLCAT462, CLCAT 469, CLCAT592, CLCAT594 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT751.

Identification. Carapace cylindrical, elongated, composed of agglutinated particles, with no spines or protuberances. The aperture is circular and without evidence of a collar. L = 100–185 µm (129 ± 37.48), W = 60–80 µm (68 ± 8.37), AP = 40–50 µm (42 ± 4.47) (*n* = 5).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo.

Family Euglyphidae Wailes, 1919

***Euglypha acanthophora* Ehrenberg, 1840**
Figure 3M

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT396, CLCAT399, CLCAT432 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT547 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT751, CLCAT756, CLCAT763.

Identification. Carapace transparent, colorless, oval, elongated, not compressed, composed of elliptic or circular plates, with 2–4 long spines in the posterior region. The aperture is terminal and circular, with serrated plates. L = 75–100 µm (84.5 ± 12.35), W = 30–60 µm (41.5 ± 8.18) AP = 20–40 µm (25.5 ± 7.61) (*n* = 10).

Distribution in Brazil. Amapá, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina.

***Euglypha filifera* Pénard, 1880**
Figure 3K

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT389, CLCAT420, CLCAT430 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT462, CLCAT548 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT592, CLCAT761.

Identification. Carapace colorless, transparent, oval, elongated, slightly compressed, with spines (usually six) in the lateral and posterior regions. The carapace plates are oval. The aperture is circular, with toothed plates. L = 50–60 µm (57 ± 4.83), W = 25–33 µm (28.05 ± 2.93), AP = 15–25 µm (17.5 ± 3.54) (*n* = 10).

Distribution in Brazil. Bahia, Distrito Federal, Maranhão, Mato Grosso, Minas Gerais, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina.

Family Hyalosphenidae Schultze, 1877

***Longinebela tubulosa* (Penard, 1890)**
Figure 4C

New record. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano), 12°45.775′S, 041°18.545′W; V.2014; CLCAT389.

Identification. Carapace colorless, transparent, pyriform, laterally compressed, composed of overlapping oval or circular plates, with the sides evenly and gradually tapering from the aboral region towards the aperture, forming a short neck, with lateral protuberances near it. The aperture is oval, with a narrow collar. L = 170–175 µm (172.5 ± 3.54), W = 90 µm, AP = 30–35 µm (32.5 ± 3.54) (*n* = 1).

Taxonomic remarks. This species can be differentiated from *Longinebela penardiana* (Deflandre, 1936) by its greater width.

Distribution in Brazil. Bahia, Minas Gerais, Rio Grande do Sul.

Family Netzelidae Kosakyan et al., 2016

***Netzelia corona* (Wallich, 1864)**
Figure 3I

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT386, CLCAT399, CLCAT421 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT592 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT748, CLCAT750, CLCAT752.

Identification. Carapace spherical, composed of agglutinated exogenous particles, posterior region has two or four (usually two) hollow conical spines. The aperture is terminal and multilobed. L = 100–140 µm (108.75 ± 13.56), W = 80–100 µm (89.38 ± 7.76) (*n* = 8).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo.

***Netzelia gramen* (Penard, 1902)**
Figure 3J

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT404, CLCAT408 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT462, CLCAT515 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT592, CLCAT760, CLCAT766.

Identification. Carapace oval, not compressed, and composed of agglutinated exogenous particles. The aperture is trilobed and with no evident collar. L = 50–80 µm (61 ± 8.76), W = 35–60 µm (50.4 ± 8.34) (*n* = 10).

Distribution in Brazil. Amapá, Amazonas, Bahia, Distrito Federal, Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo.

Family Trinematidae Hoogenraad & Groot, 1940

***Trinema enchelys* (Ehrenberg, 1838)**
Figure 3O

New records. BRAZIL – Bahia • Andaraí, Pantanal dos Marimbus (Baiano); 12°45.775′S, 041°18.545′W; V.2014; CLCAT396, CLCAT422, CLCAT431 • same locality; 12°45.416′S, 041°18.516′W; IX.2014; CLCAT463, CLCAT515 • same locality; 12°45.916′S, 041°18.777′W; IV.2015; CLCAT594, CLCAT766.

Identification. Carapace elongated, composed of circular, incompletely overlapping plates, tapering towards the aperture in lateral view. The aperture is circular, with internal denticulate plates, subterminal, and invaginated. L = 50–85 µm (66.67 ± 13.92), W = 25–40 µm (31.67 ± 6.61), AP = 15–20 µm (17.22 ± 2.64) (*n* = 9).

Distribution in Brazil. Amazonas, Bahia, Maranhão, Mato Grosso, Minas Gerais, Piauí, Rio de Janeiro, Rio Grande do Sul.

Discussion

The most taxon-rich families in our study, Arcellidae, Centropyxidae, and Difflugiidae, were also identified as the most representative in other studies of testate amoebae in both plankton and periphyton (Velho et al. 1999; Fulone et al. 2005; Lansac-tôha et al. 2008; Alves et al. 2008, 2010, 2012; Oliveira and Hardoim 2010). Alves et al. (2010) observed a greater richness of testate amoebae in the periphyton than in plankton in a lagoon in the upper Paraná River floodplain, as aquatic macrophytes increase habitat heterogeneity and allow greater testate amoebae diversity, stability (Agostinho et al. 2007), and productivity (Souza 2005; Chambers et al. 2008).

Although taxon richness was greater in the periphyton, both the periphyton and plankton were rich in testate amoebae. The high richness of testate amoebae observed in our samples suggests that those protozoans can

adapt to many different aquatic environments, enabling their movement and establishment in multiple habitats (Miranda and Mazzoni 2015).

Arcella stood out as the most common genus in both the plankton and periphyton. According to Velho et al. (1999) and Lansac-Tôha et al. (2014), the presence of a gaseous vesicle and a low-density thecae allows their permanence in the plankton, and thus their wide distribution. The 15 newly recorded taxa of testate amoebae from Bahia elevate their diversity in the state to 166 taxa. Of those 15 new taxa, *A. costata* var. *angulosa* and *D. microclaviformis* occurred in both plankton and periphyton habitats, as was previously noted by other authors (Alves et al. 2007; López 2009; Matsumura-Tundisi et al. 2015; Schwind et al. 2016; Souza 2018; Gomes 2019; Souza et al. 2019), evidencing their ability to colonize different environments and substrates. *Arcella peruviana*, on the other hand, was found exclusively in plankton. Souza (2018) also reported *A. peruviana* in plankton in Brazil, and Reczuga et al. (2015) and Swindles et al. (2016) recorded it in peat moss. That species is associated with acidic habitats (Souza 2018) and can be useful an indicator of peat moss humidity in the tropics (Reczuga et al. 2015). All of the other newly reported species were found exclusively in the periphyton.

Of the taxa reported here for Bahia for the first time, seven belong to the family Hyalosphenidae. Previously, only three species of this family were known for the state: *Padaungiella lageniformis* (Penard, 1890) and *Longinebela tubulosa* (Penard, 1890), both associated with the periphyton (Silva et al. 2009), and *Alabasta longicolis* (Penard, 1890), associated with sediments (Cruz 2012). Hyalosphenids are often found in moist oligotrophic habitats, such as sphagnum, although they are also found in other habitats, including on other mosses, in freshwater, and in the soil (Mitchell et al. 2000; Todorov 2010).

According to Lansac-Tôha et al. (2007), the fragile carapaces of *Nebela* (now placed in *Cornutheca* Kosakyan, Lahr, Mulot, Meisterfeld, Mitchell & Lara 2016, *Gibbocarina* Kosakyan, Lahr, Mulot, Meisterfeld, Mitchell & Lara 2016, *Longinebela* Kosakyan, Lahr, Mulot, Meisterfeld, Mitchell & Lara 2016, *Mrabella* Kosakyan, Lahr, Mulot, Meisterfeld, Mitchell & Lara 2016, *Padaungiella* Lara & Todorov, 2012, and *Planocarina* Kosakyan, Lahr, Mulot, Meisterfeld, Mitchell & Lara 2016), limit their occurrence in plankton. Additionally, those taxa have hyaline carapaces, and exposure to light in planktonic habitats can be prejudicial to their protoplasm – thus reducing their occurrence in that habitat. *Nebela* has been most frequently reported in plankton in Brazil (Alves et al. 2007, 2008; Oliveira and Hardoim 2010; Schwind et al. 2016; Picapedra et al. 2017; Souza 2018; Gomes 2020), with few reports of their presence in the periphyton (Souza 2005; López 2009) or in sphagnum (Wailes 1913; Rhoden and Pitoni 1999), although studies of testate amoebae in periphyton or peat moss are even more scarce than studies in plankton.

The Pantanal dos Marimbus contains an expressive richness of testate amoebae (61 taxa), and the 15 taxa of testate amoebae reported here significantly increases the number of taxa known to Bahia (a total of 166) and northeastern Brazil. In addition, our study evidenced the greatest number of hyalospheniid species in the state, bringing that number of species to 10. Thus, the Pantanal dos Marimbus, in addition to possessing landscapes of immense beauty, harbors a very expressive testate amoebae fauna, with species little known for the state – thus reinforcing its importance as an area of high biological richness.

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